CHAPTER VI. FACTORS CONTRIBUTING TO INFANT DEATHS IN KING COUNTY: SUMMARY OF THE CASE-BY-CASE REVIEW

This chapter describes the factors contributing to infant mortality in King County as identified through the review of the cases of 247 infants who died during the 1992-94 period. During this time, 399 infants who were residents of King County died. Among these infants, 262 were eligible for inclusion in this review (refer to Chapter V for eligibility criteria). Medical records were obtained for all eligible cases, interviews were conducted for 173, and expert committee review completed for 247 (Table 6.1).

TABLE 6.1
CASE REVIEW STATUS FOR KING COUNTY INFANT DEATHS, 1992-1994

	Number of Cases	Percent of Total	Percent of Eligible
Total Infant Deaths in King County	399	100.0	---
Total Eligible for Review by Expert Panel	262	65.7	100.0
Total Reviewed by Expert Panel	247	61.9	94.3
Interviewed	173	43.4	66.0
Refused	48	12.0	18.3
Unable to Interview	41	10.3	15.6
Cases Pending Review	15	3.8	5.7

The Review identified at least one contributing factor in 49 percent of the 247 infant deaths reviewed (Table 6.2). Factors that were both highly important and highly modifiable occurred in 29 cases (12 percent of the total). The identification of these factors offers guidance in planning the next steps to further reduce infant mortality in King County.

The types of factors varied among the major causes of infant death. We therefore summarized the contributing factors for each cause of death separately. More than half of the cases within each cause of death, except congenital anomalies and SIDS, had contributing factors. Nearly all deaths caused by prematurity and external causes had contributing factors. Because contributing factors could not be assigned to cases in which the cause of death was unknown, none were assigned to SIDS cases.[a] Only cases associated with external causes and perinatal conditions had high proportions of contributing factors which were both highly important and highly modifiable. While many of the factors in the prematurity cases were highly important, few were considered modifiable.

TABLE 6.2
NUMBER OF CASES WITH CONTRIBUTING FACTORS AND WITH HIGHLY IMPORTANT/HIGHLY MODIFIABLE (HIGH IMP/MOD) CONTRIBUTING FACTORS IN EACH CAUSE OF DEATH GROUP

Cause of Death	Number of Cases	Number of Cases with Contributing Factors	Percent of Cases with Contributing Factors	Number of Cases with High Imp/ Mod Factors	Percent of Cases with High Imp/ Mod Factors
Prematurity	87	82	94.3	7	8.0
Perinatal Conditions	29	20	69.0	12	41.4
Congenital anomalies	33	5	15.2	3	9.1
External Causes	9	9	100.0	7	77.8
Other Infections	5	3	60.0	0	0.0
Other Miscellaneous	10	1	10.0	0	0.0
SIDS[1]	74	0	0.0	0	0.0
Total	247	120	48.6	29	11.7

1) BY THE DEFINITION OF CONTRIBUTING FACTOR USED BY THE REVIEW, SIDS CASES WERE NOT ASSIGNED CONTRIBUTING FACTORS (SEE TEXT)

The following sections describe in more detail the contributing factors for each major cause of death.

[a] The cause(s) of SIDS remain an area of active research.

PREMATURITY

Eighty seven infants died of prematurity or prematurity-related complications.[b] At least one contributing factor was present in 82 of these cases (94 percent). Six broad groups of contributing factors occurred among these cases (Table 6.3). The largest groups were maternal pregnancy-related health complications and problems with the delivery of health services.

TABLE 6.3
FACTORS CONTRIBUTING TO CASES WITH PREMATURITY AS CAUSE OF DEATH (TOTAL CASES = 87)

Factor Group	Cases with Factor Group	Percent of Cases with Factor Group*
Maternal health problems predating the pregnancy	3	3.4
Maternal health problems arising during pregnancy and delivery	81	93.1
Medical/Obstetrical complications of pregnancy	81	93.1
Trauma during pregnancy	1	1.1
Socioeconomic and behavioral factors during pregnancy	7	8.0
Health services problems	23	26.4
Health services problems during pregnancy	21	24.1
Health services problems during labor and delivery	6	6.9
Labor and delivery factors	3	3.4
Neonatal/Postneonatal factors	6	6.9

* BECAUSE A CASE MAY HAVE MORE THAN ONE FACTOR OR NO FACTORS THESE PERCENTAGES DO NOT SUM TO 100.

Seven of the 87 infants (8 percent) had factors that were both highly important and highly modifiable. Table 6.4 describes these factors.

TABLE 6.4
HIGHLY IMPORTANT AND HIGHLY MODIFIABLE CONTRIBUTING FACTORS FOR PREMATURITY DEATHS (TOTAL CASES =87)

Factor Group	Factor	Cases with Factor	Percent of Cases with Factor
Socioeconomic and behavioral factors during pregnancy		1	1.1
	Job-related stress due to high physical demands		
Health services problems during pregnancy and labor and delivery		6	6.9
	Inadequate patient education regarding symptoms of preterm labor/preterm premature rupture of membranes by provider		
	Inadequate evaluation and treatment of preterm labor		
	Failure to detect multiple gestation		

The following sections explore the prematurity-related factors in further detail and offer explanations of how they contributed to infant deaths.

[b] There were 5 sets of twins who died of prematurity. For conditions that pertain to mothers, such as management of preterm labor, each set is counted as one case. For conditions that are relevant to the infants, such as an infant lung infection, each infant of the twin set is counted as one case.

MATERNAL HEALTH PROBLEMS WHICH PREDATED PREGNANCY

This small group of contributing factors consisted of a maternal psychiatric problems and cases with histories of cone biopsies of the cervix. This group of factors was present in three of the mothers (3 percent) whose infants died of prematurity.

The relationship between psychological illness in pregnant women and poor birth outcomes is a poorly researched area. Some evidence exists that psychological disorders can lead to adverse pregnancy outcomes.[1] [2] The effects of psychological disorders can be mediated directly through physiological mechanisms or indirectly through adverse health behaviors such as smoking, alcohol use and drug consumption. [3] [4] [5] Proposed physiological mechanisms include impairment in the function of the placenta resulting in impaired fetal growth or the increased production by the body of certain chemicals (catecholamines) that may precipitate preterm delivery. Psychological disorders may also constitute a barrier for a pregnant woman to adequately participate in prenatal care,[6] which in turn can hinder proper management of the pregnancy. Additionally, mental health problems can impede patient education and maternal involvement with the pregnancy. The side effects of medications used to treat mental disorders have also been associated with poor birth outcomes.[7]

Other cases in this group were women with histories of cone biopsies. Cone biopsy is used as a treatment for certain diseases of the cervix, such as cervical cancer. This procedure involves excision of tissue from the cervix, which may alter its shape and function and lead to a condition called cervical incompetence. This condition causes the cervix to open abnormally in the second trimester of pregnancy, resulting in premature birth. Under selected circumstances, a procedure called cerclage can be performed during pregnancy to prevent an early delivery due to an incompetent cervix. Infection, premature rupture of membranes, and preterm labor and delivery were conditions that accompanied the cases with a history of cone biopsy.

Although mental illness and history of cone biopsy were identified by the Review as contributing to the infant's death, none of these factors were rated as being highly modifiable due to lack of conclusive research regarding preventive measures for these conditions.

MATERNAL HEALTH PROBLEMS DURING PREGNANCY AND DELIVERY

The largest group of factors contributing to infant death due to prematurity was medical and obstetrical disorders during pregnancy. Such complications were present in 81 mothers (93 percent) whose infants died of prematurity, and consisted mainly of preterm labor, preterm premature rupture of fetal membranes,[c] chorioamnionitis, and multiple gestation.[d]

Preterm premature rupture of fetal membranes is often the event which initiates preterm labor.[8] [9] [10] In some cases early rupture of membranes is caused by an inflammation of the fetal membranes, known as chorioamnionitis. Chorioamnionitis is probably caused by infections such as group B streptococcus, chlamydia and bacterial vaginosis.[11] [12] [13] Rupture of fetal membranes can also occur due to trauma from falls or motor vehicle injuries.

None of the mothers with health problems during pregnancy had highly modifiable conditions. Despite the strong evidence that chorioamnionitis and preterm premature rupture of membranes are associated with preterm labor and delivery, and despite the high prevalence of these conditions among mothers

[c] Spontaneous rupture of the fetal membranes [bag of water] before term and the onset of labor
[d] Greater than one fetus in the womb

whose infants' died of prematurity during the review, they are not currently highly preventable conditions. More clinical and basic science research is needed to develop effective preventive measures for these conditions.

SOCIOECONOMIC AND BEHAVIORAL FACTORS DURING PREGNANCY

A total of seven prematurity cases (8 percent) had socioeconomic or behavioral factors contributing to the death of the infant. These factors included job-related physical stress and drug use.

Physically challenging work contributed to the development of preterm labor. Excessive exertion (but not ordinary levels of physical activity) during pregnancy can increase the occurrence of preterm labor.[14 15 16] Such stress can cause the body to produce certain substances (catecholamines and oxytocin) which increase contractions of the uterus (womb).[17] It can also cause the body to produce other substances (corticosteroids) that makes women more vulnerable to infections, particularly chorioamnionitis, which in turn can lead to preterm labor.

Drug use, particularly cocaine, contributed to six infant deaths. Cocaine has been reported to increase poor fetal outcomes, such as preterm birth and low birthweight.[18 19 20] In addition to the heart and brain problems that affect the mothers who use drugs,[21 22] potential hazards to the fetus include problems with the blood vessels of the brain, early separation of the placenta from the uterus and increased uterine contractions leading to preterm labor.[23 24] The abuse of cocaine in these specific cases did not appear to be preventable.

The following vignette (as are all others in this report) is a composite of several similar cases written to illustrate some of these issues while preserving the privacy of the individuals involved.

ILLUSTRATIVE VIGNETTE: Susan (a fictitious name) became pregnant for the second time when her youngest child was two years old. She had been under a great deal of stress because of arguments with her partner and difficulty finding a place to live. In the past she had used cocaine occasionally, and as the pregnancy progressed she resumed drug use. When she was 25 weeks pregnant, she went into early labor after using cocaine and delivered a premature baby. The baby died of complications of prematurity within a few hours of birth.

Tobacco is another commonly used substance that strongly increases the risk of early labor.[25 26] Smokers are at increased risk of preterm premature rupture of fetal membranes and early separation of the placenta from the uterus. [27 28] These conditions may occur because smokers have lower levels of oxygen and elevated levels of carbon monoxide in their blood, which make less oxygen available for their body tissues (including the placenta).[29] As described in Chapter II (Trends in Infant Mortality), fourteen percent of all mothers in King County smoked during pregnancy in the 1992-94 period and the mothers of 38% of the cases included in the Review were smokers. Because of the difficulty of conclusively concluding in any individual case that smoking caused that particular death, the Review decided not to include smoking as a contributing factor, but recognize smoking as an important and modifiable risk factor at the population level.

Further discussion of the socioeconomic and behavioral issues associated with infant mortality is contained in Chapter VII. A subsequent report will address issues of substance abuse among pregnant women and parents of infants.

HEALTH SERVICES ISSUES

This group was the second largest group of factors contributing to deaths from prematurity and occurred in 23 of the premature infants (26 percent). Six of these cases (7 percent) had highly important and highly modifiable factors, which made this group the largest for which interventions might reduce infant deaths. Inadequate prenatal care, inadequate management of preterm labor, patient knowledge deficits regarding symptoms of preterm labor and warning signs for obstetrical problems because of inadequate patient education by the provider, inadequate social services, and inappropriate level of delivery facility to manage the high risk status of the pregnancy were the most common contributing factors.

ILLUSTRATIVE VIGNETTE: Mary (a fictitious name) was pregnant for the fourth time. She was at increased risk for early labor because she previously had a premature birth. During this pregnancy she had some obstetrical problems and sought care from her provider. She received an ultrasound, which was normal. However, she was not checked for early signs of labor, such as opening of the cervix. That evening she was admitted to the hospital in active labor. She delivered a premature baby who subsequently died from complications of prematurity.

Further details and recommendations for interventions to improve support services and health services are presented in detail in Chapters VIII (Improving Support Services For Pregnant Women and Infants) and IX (Improving Care During Labor and Delivery).

LABOR AND DELIVERY FACTORS

Three mothers (3 percent) had factors contributing to their infant's death which were related to complications of labor and delivery. None were considered highly preventable. These conditions included precipitous labor (a condition where labor progresses so rapidly that it becomes very difficult to arrive at a medical facility before delivery occurs), and out-of-hospital unattended birth.

NEONATAL/POSTNEONATAL FACTORS

Six premature infants (7 percent) had factors arising in the period soon after birth that contributed to their death. None of them were considered preventable. These factors consisted of complications of prematurity (particularly breathing problems), infections and intrauterine growth retardation.[e]

SUMMARY

Among infants who died of prematurity, pregnancy complications and health services problems were the major contributors their deaths. The elimination of these problems would not necessarily have changed the outcomes for all of these infants because of the uniqueness of each case and the complexity of mechanisms that lead to preterm labor. Nonetheless, efforts to reduce the occurrence of these factors have great potential to improve the health of pregnant women and infants in King County. The Review will examine all cases in which prematurity was the cause of death and issue recommendations for preventing such deaths in a future report.

[e] Intrauterine growth retardation is the delayed development and maturation of the fetus due to genetic factors, infection, maternal disease, or fetal malnutrition caused by placental problems which result in an infant whose weight and size at birth is very small (below the tenth percentile).

PERINATAL CONDITIONS

Twenty nine of the infants included in the Review died of perinatal conditions, which are problems that cause the death of an infant during the first four weeks of life They included problems with the lungs, injuries, lack of oxygen during birth and infections. At least one contributing factor was identified in twenty of these cases (69 percent). Five broad categories of contributing factors emerged (Table 6.5). Health services problems, particularly during labor and delivery, and health problems during pregnancy were the largest groups.

TABLE 6.5
CONTRIBUTING FACTORS FOR PERINATAL CONDITIONS AS CAUSE OF DEATH (TOTAL CASE =29)

Factor Group	Cases with Factor Group	Percent of Cases with Factor Group
Health problems during pregnancy	10	34.5
Medical/Obstetrical pregnancy complications	10	34.5
Socioeconomic and behavioral factors during pregnancy	2	6.9
Health services problems	17	58.6
During pregnancy	6	20.7
During labor and delivery	12	41.4
During neonatal/ postneonatal period	3	10.3
Labor and delivery factors	4	13.8
Neonatal/Postneonatal factors	2	6.9

* BECAUSE A CASE MAY HAVE MORE THAN ONE FACTOR OR NO FACTORS THESE PERCENTAGES DO NOT SUM TO 100.

Twelve of these 29 infants (41 percent) had highly important and highly modifiable contributing factors. Table 6.6 summarizes the highly important and highly modifiable contributing factors among infants dying of perinatal conditions. Most of these factors were technical issues arising during the medical management of labor and delivery.

TABLE 6.6
HIGHLY MODIFIABLE AND HIGHLY IMPORTANT
CONTRIBUTING FACTORS FOR PERINATAL CONDITIONS (TOTAL CASES =29)

Factor Group	Factor	Cases with Factor	Percent of Cases with Factor
Health services		11	37.9
During pregnancy		3	10.3
	Inadequate management of pregnancy induced hypertension.		
	Lack of patient knowledge to report decreased fetal movement promptly[1]		
During labor and delivery		9	31.0
	Delayed diagnosis and treatment of fetal distress		
	Inappropriate management of labor leading to delayed cesarean section		
	Lack of recognition of abnormal course of labor resulting in fetal distress		
	Inadequate fetal monitoring during labor		
	Failure to follow reasonable protocol for using Pitocin for induction of labor.		
	Lack of timely intubation, suctioning, and ventilation of newborn with respiratory distress.		
	Emergency services (911) not called for transport of infant with respiratory compromise to hospital		
	Discontinuity of prenatal and labor & delivery care caused by involvement of multiple providers		
During Neonatal/Postneonatal Period		2	
	Inadequate diagnosis and management of infant with sepsis (severe infection)		

[1] DECREASED FETAL MOVEMENTS MAY INDICATE FETAL ILL HEALTH

The Obstetric Subcommittee reviewed of many of these cases and developed recommendations to prevent the future occurrence of these factors (Chapter IX). While preventing them might not have changed the outcome for all of these infants because of the complexity and interaction of the various mechanisms that contributed to these deaths, avoiding these circumstances would improve infant and maternal health in King County.

CONGENITAL ANOMALIES

Thirty three of the infants in the Review died of congenital anomalies (birth defects). At least one contributing factor was assigned for five (15 percent) of these cases. Three of these 33 infants (9 percent) had highly important and highly modifiable contributing factors. Five broad categories of contributing factors were identified (Table 6.7). The factors were not concentrated in one or two specific factor groups as they were in the other causes of death.

TABLE 6.7
CONTRIBUTING FACTORS FOR CONGENITAL ANOMALIES AS CAUSE OF DEATH (TOTAL CASES = 33)

Factor Group	Cases with Factor Group	Percent of Cases with Factor Group
Maternal health history and prior adverse pregnancy outcome	1	3.0
Complications during pregnancy	1	3.0
Medical/Obstetrical pregnancy complications	1	3.0
Socioeconomic and behavioral factors during pregnancy	1	3.0
Health services problems	3	9.1
During pregnancy	1	3.0
During labor and delivery	1	3.0
During neonatal/ postneonatal period	1	3.0
Neonatal/Postneonatal factors	2	6.1

* BECAUSE A CASE MAY HAVE MORE THAN ONE FACTOR OR NO FACTORS THESE PERCENTAGES DO NOT SUM TO 100.

Table 6.8 lists the highly important and highly modifiable contributing factors for infants dying of congenital anomalies.

TABLE 6.8
HIGHLY MODIFIABLE, HIGHLY IMPORTANT CONTRIBUTING FACTORS FOR CONGENITAL ANOMALIES CAUSE OF DEATH (TOTAL CASES = 33)

Factor Group	Factor	Cases with Factor Group	Percent of Cases with Factor Group
Health services		3	9.1
During pregnancy	Lack of genetic counseling and education regarding pregnancy options despite elevated maternal risk of delivering infant with anomalies		
During neonatal/ postneonatal period	High risk pediatric surgery performed at a level II hospital instead of a level III hospital.		
Neonatal/Postneonatal infection	Hospital acquired infection after surgical repair of congenital condition		

Very few cases had highly important and highly modifiable factors. Because of this low yield, the Review stopped considering deaths caused by congenital anomalies after mid 1993. In nearly all of the cases with congenital anomalies, we noted that appropriate and aggressive interventions were performed to improve infant survival. This observation supports the hypothesis that the declining death rate of infants with congenital anomalies was in part due to improved care of these newborns.

EXTERNAL (ACCIDENTAL) CAUSES OF DEATH

Nine infants died of external causes (accidents). External causes of death included suffocation and trauma due to motor vehicle accidents. At least one contributing factor was assigned for all of these cases. Two broad categories of contributing factors were identified (Table 6.9).

TABLE 6.9
FACTORS CONTRIBUTING TO EXTERNAL CAUSES OF DEATH (TOTAL CASES=9)

Factor Group	Cases with Factor Group	Percentage of Cases with Factor Group
Socioeconomic and behavioral factors	9	100.0
During pregnancy	4	44.4
During neonatal/Postneonatal Period	5	55.6
Health Services Problems	4	44.4
During pregnancy	2	22.2
During neonatal/postneonatal period	4	44.4

* BECAUSE A CASE MAY HAVE MORE THAN ONE FACTOR OR NO FACTORS THESE PERCENTAGES DO NOT SUM TO 100.

This group, though small, had a higher proportion of cases with highly important and highly modifiable factors than any other cause of death. Seven of these nine infants (78 percent) had highly important and highly modifiable contributing factors

Table 6.10 illustrates the highly important and highly modifiable contributing factors for infants dying of external causes. In most of these cases, the infants died from accidental asphyxia (suffocation) caused by sleeping in unsafe places. Examples of unsafe locations included cribs in poor repair, sleeping on soft adult bedding or couches, or being placed in reach of dangerous objects. Other studies have confirmed the importance of dangerous sleep environments in contributing to accidental infant deaths. A study of infant deaths from unintentional injuries in Kentucky identified mechanically unsafe sleeping situations as the largest contributor.[30]

TABLE 6.10
HIGHLY MODIFIABLE, HIGHLY IMPORTANT CONTRIBUTING FACTORS FOR EXTERNAL CAUSES OF DEATH (TOTAL CASES = 9)

Factor Group	Factor	Cases with Factor	Percent Cases with Factor
Socioeconomic and behavioral factors		6	66.7
	Drug use		
	Unsafe sleep environment: Crib in poor repair; infant in unsafe noncrib location; unsafe object in crib		
	Lack of car seat use resulting in death from motor vehicle accident		
Health Services		2	22.2
	Poor coordination of services between child protective services and public health nurse		
	Lack of parent education regarding child safety		
	Inadequate public health nurse services, resulting in lack of evaluation of sleep environment for the infant.		
	Lack of coordination of services between substance abuse treatment programs, child protective services and public health department		

In most cases, several factors interacted to cause the death. For example, substance abuse may have impaired a caretaker's ability to assure a safe sleep location. A breakdown in interagency communication between Public Health Nursing, a substance abuse treatment program, and Child Protective Services resulted in a lack of evaluation of the living circumstances of a family, including an assessment of the infant's sleep environment, which would have revealed safety issues.

Many of these deaths could have been prevented by simple measures to assure that infants sleep in safe conditions such as those described in the following recommendations:

SLEEP SAFETY RECOMMENDATIONS

- Every baby needs a safe place to sleep, every time it goes to sleep, no matter where or when. This includes naps during the day as well as night time sleeping. Infants should have a crib to sleep in which is in good repair with a firm mattress. No soft bedding such as fluffy comforters, sheepskins or pillows should be under the baby or in the crib. The number of objects in the crib should be limited.
- Infants should avoid sleeping in the prone (on the stomach) position. It is safer for babies to sleep on the side or back. This includes naps as well as night time sleeping.
- Infants should not sleep on beds, couches, and other places not designed for infant sleep safety. Additionally, sleeping on couches with multiple individuals is to be avoided.
- Rocking cradles are potentially dangerous, particularly those that may have defective mechanisms for stabilizing the cradle.
- Day care and foster care facilities should provide a safe sleeping environment for each infant at all times.
- Baby-sitters should be aware of safe sleeping practices for infants.

INFECTIONS IN THE POST-NEONATAL PERIOD

Five of the infants in the Review died of infections occurring after the first four weeks of life.[f] The most common infection was caused by the respiratory syncytial virus, which causes pneumonia. At least one contributing factor was assigned for three (60 percent) of these cases. Four broad categories of contributing factors were identified (Table 6.11). None had highly important and highly modifiable contributing factors.

TABLE 6.11
FACTORS CONTRIBUTING TO INFECTIOUS CAUSES OF DEATH (TOTAL CASES = 5)

Factor Group	Cases with Factor Group	Percent Cases with Factor Group
Complications during pregnancy	1	20.0
Medical/Obstetrical complications	1	20.0
Socioeconomic and behavioral factors	1	20.0
During pregnancy	1	20.0
Health services	2	40.0
During neonatal/postneonatal period	1	20.0
Neonatal/Postneonatal factors	3	60.0

* BECAUSE A CASE MAY HAVE MORE THAN ONE FACTOR OR NO FACTORS THESE PERCENTAGES DO NOT SUM TO 100.

No particular group of factors predominated for this cause of death.

[f] Perinatal infections are discussed in Chapter IX.

MISCELLANEOUS CAUSES OF DEATH

Ten infants died of miscellaneous causes of death. These miscellaneous causes of death included unexplained cardiac arrest, apnea (cessation of breathing), and brain and blood disorders. Only one case had a contributing factor, which was not considered to be highly important and highly modifiable.

CONCLUSIONS

The Infant Mortality Review identified modifiable contributing factors in twelve percent of the infant deaths reviewed. Health and social services issues, adverse social conditions and environmental safety concerns figured prominently alongside more traditional medical, biological, and behavioral risk factors. Highly important and highly modifiable factors were most likely to be found in deaths from perinatal conditions and external causes. The Review has developed recommendations, based on their review of the cases, for improving maternal and infant health in King County (see Chapter X). These recommendations are currently being implemented by a range of health and human service agencies, voluntary community organizations and professional groups. While implementing these recommendations might not have changed the outcome in all the cases considered by the Review, doing so would help to prevent many infant deaths and contribute to further reduction in the County's infant mortality rate. Ongoing case-by-case review to assess factors contributing to infant deaths, especially among ethnic groups and geographic areas with high infant death rates, is an important tool to decrease infant mortality to its lowest possible rate.

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